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(54) A float board.

(57) A float board 10, and method of manufacturing such a float board 10, comprises a hollow shell 12 of composite materials, usually carbon fibre reinforced plastics enclosing a core material 44, having internal support walls 20 and 24 to support the shell and divide the interior of the board 10 into separate watertight compartments 30, 32 and 34. Pressurisable bladders 50, 52 may be incorporated within each separate compartment 30, 32 and 34 to allow the buoyancy and rigidity of the board to be adjusted.

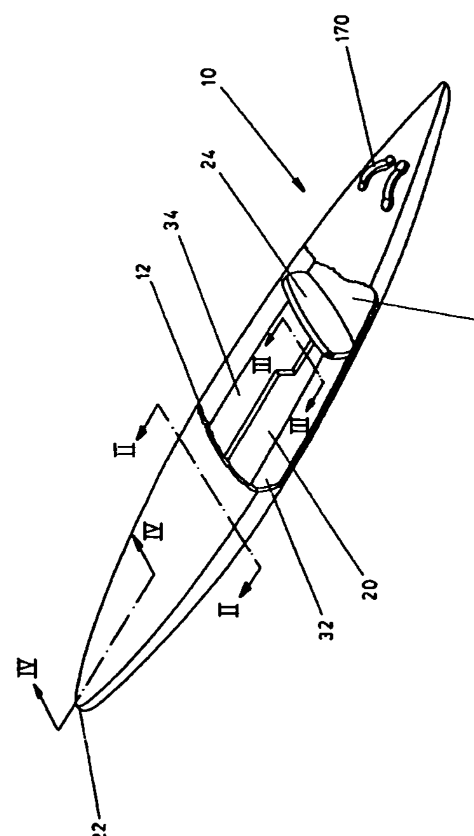

FIG. 1

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TECHNICAL FIELD

The present invention relates to float boards of the kind commonly used in water sports such as surf boarding and windsurfing and is equally applicable to other types of water craft employing float boards, such as rafts and catamarans.

BACKGROUND ART

Float boards of the kind referred to are commonly known and are usually contoured to provide a suitable section to enable them to float on the surface of the water with as little penetration beneath the water as possible, and for this reason they should be as light as possible. Furthermore, such boards need to be sufficiently strong to withstand the weight of the user (i.e. a surfer or sailboarder on the appropriate board) and also to accept buffeting as the board strikes waves and surf, or shingle as it approaches the shoreline.

With the foregoing in mind, existing float boards are usually constructed in one of three ways. The most common boards are mass produced constructed from an expanded polystyrene core moulded to the required shape and then encased within a tough, pre-formed vacuum moulded plastics shell. Alternatively, float boards may be custom built in small workshops where an expanded polystyrene core is shaped by hand to a required profile and then encased by bonding in a shell of one or more layers of thin, but strong, composite material such as a cured glass fibre skin or a thermoplastics skin. Other materials such as ceramic, carbon fibre, that sold under the Trade Mark KEVLAR; (honeycomb layers or chopped strand mat may also be used in the shell).

An important feature of a float board is the combination of strength (rigidity) and lightness of the board and the choice of the materials from which it is constructed is usually made with this in mind. However, it is generally found that to attain a desirable light weight the strength of the board is sacrificed by reducing the thickness of the shell (for example by reducing the number of layers in the shell) and as a consequence of buffeting by waves, cartage or transport of the board (typically on a car roof rack) and even the loading through a user's feet, can often cause dents or depressions in the surface of the shell with the consequence that the board is weakened. Furthermore, the lower the rigidity to weight ratio then the greater are vibrations which may develop in the board, making it less responsive and harder to control. The predominant weight of known float boards arises from the use of a polystyrene core and the overall weight of the board is generally reduced by using a thinner shell which tends to reduce the rigidity and hence speed, of the board.

The third known method of making float boards eliminates the use of a polystyrene core by forming one piece hollow boards in plastics as rotary mouldings. However, these boards have proved to be impractical, and hence commercially unsuccessful, since they are both heavy and lack rigidity. To increase the strength of such boards would necessitate that the thickness of the shell is increased, but this would greatly increase the weight, alternatively the only way to reduce the weight would be to reduce the shell thickness, which would greatly reduce the rigidity of the board.

It is an object of the present invention to provide a float board of the kind discussed, and a method of manufacture of such a board, which alleviates the aforementioned problems and may provide a rigidity to weight ratio higher than boards manufactured by conventional known methods.

SUMMARY OF INVENTION AND ADVANTAGES

In accordance with the present invention there is provided a float board comprising a watertight shell, said shell being hollow and having a wall structure with an outer surface presented by a cured resin composite material. The wall structure may be in the form of a double skin of moulded composite material having a core material disposed therebetween. Such composite material will preferably comprise fibre reinforced plastics material having predominantly carbon fibres, while the core material may comprise a honeycomb layer.

The use of cured resin fibre reinforced materials, such as carbon fibre, results in increased thermal stability since such materials have a continuous operating temperature of up to 120°C. This is obviously beneficial since the boards are often used in parts of the world where the boards can reach 70°C and at such temperatures residual blowing agents in the polystyrene core of existing boards start to expand and distort these existing boards. Without the problem of a polystyrene core there is no restriction on the colour of the boards, heat absorbing dark colours may now be used as well as light colours for aesthetic appearance. Conventional boards must avoid dark colours to reduce heat absorbtion.

Preferably, the hollow shell has support parts comprising at least one layer of cured resin composite material, and usually comprise a double skin of said cured composite material sandwiching a core material. These support parts will usually divide the interior of the shell into at least two chambers.

In a preferred embodiment of the invention, pressurisation means may be provided for adjusting the internal pressure of the shell and thereby adjusting the stiffness of the board. This pressurisation means will usually comprise at least one envelope within the shell and valve means communicating with the exterior of the shell through which the pressure within the

envelope may be adjusted. Where the interior of the shell has been divided into chambers, at least two of these chambers may each have a separate said envelope with associated valve means by which each said envelope may have the pressure therein individually adjusted. This allows the strength (or stiffness) characteristics of the board to be adjusted to suit individual requirements and localised conditions. The pressurisation means usually comprises gas under pressure being retained in the shell, preferably within the said envelopes. By using different gasses having different densities it may be possible to adjust the buoyancy of the board and also adjust the buoyancy characteristics of the board by using different gasses in different chambers within the shell. Usually helium gas, which is, less dense than air, is used to enhance the lightness, and hence buoyancy, of the board.

A float board of the type described may also comprise a mast box and a power box formed integral with the moulded shell, providing a strong connection for the mast. Furthermore, at least one stabilizing fin may also be formed integral with the moulded shell.

Preferably, a float board according to the present invention is preferably formed as a shell in which the shell comprises at least two separate moulded portions adhesively secured or bonded together, although the shell will usually comprise two adhesively bonded portions, an upper and lower portion.

Float boards according to the present invention will usually be used in combination with a mast and sail attached, although surf boards with integrally formed stabilizing fins may also comprise float boards of this type.

Further according to the present invention there is provided a method for making a float board, having a hollow shell, which comprises laying in each of at least two mould cavities of respective moulding tools a layer of composite material having resin impregnation, curing said resin impregnated materials to form shell parts and securing the shell parts together by at least one of bonding or adhesion to provide the hollow shell with a watertight external surface presented by the cured resin composite material.

Still further according to the present invention there is provided a method of making a float board, having a hollow shell, which comprises laying in each of at least two mould cavities of respective moulding tools a layer of composite material having resin impregnation, consolidating said resin impregnated layers in their respective mould cavities by the application of pressure to form un-cured shell parts, uniting the moulding tools such that the un-cured shell parts are assembled to form a hollow un-cured shell, applying an internal pressure to the hollow un-cured shell while curing the resin impregnated material to secure the shell parts together by at least one of bonding or adhesion. Consolidation of the layers usually comprises placing an airtight lining across each moulding tool to overlie the layers in the tools and applying a vacuum between the lining and the tool to cause a pressure differential by which the resin impregnated material is compressed against the moulding tool.

Both of these methods of making float boards usually comprises laying a core layer of honeycomb material between successive layers of the resin impregnated composite material.

These methods of making float boards may also comprise inserting at least one inflatable envelope between the shell parts and inflating these envelope or envelopes during the curing of the resin impregnated material to compress the un-cured shell parts against their respective moulding tools.

DRAWINGS

Embodiments of a float board constructed in accordance with the present invention will now be described, by way of example only, with reference to the accompanying illustrative drawings, in which:-

FIGURE 1 is a perspective view of a float board according to the present invention, having a section of its shell removed for clarity;

Figure 2 is a cross part section of the board shown in Figure 1 along the line II-II;

Figure 3 is a cross part section of the board of Figure 1 along the line III-III; and

Figure 4 is a longitudinal part section of the board of Figure 1 along the line IV-IV.

Figure 5 is a cross section of a moulding tool for moulding a top portion of the board with the board material layed-up for moulding.

Figure 6 is a cross section of a moulding tool for moulding a bottom portion of the board with the board material layed-up for moulding.

Figure 7 is a cross section of the combined moulding tools of Figures 5 and 6 for moulding the complete float board with the board material layed-up within the tools.

DETAILED DESCRIPTION OF THE DRAWINGS

As seen in Figure 1, a float board 10 comprises a longitudinally extending hollow shell 12 formed by moulded upper 14 and lower 16 portions which are to form a top deck and bottom deck respectively (as best seen in Figure 2) when connected together. The board 10 has the overall shape of a conventional windsurfing board. The two portions 14 and 16 of the shell 12 have internally projecting peripheral flanges 14a and 16a respectively which are aligned and secured together to connect the two portions 14 and 16 to form a watertight seal (usually by adhesive bonding, but other methods may be used).

To provide additional strength to the shell 12, a vertical and longitudinally extending wall 20 extends partway along the internal length of the shell 12 from

a rear apex 22. This longitudinally extending wall 20 terminates against a transversely extending support wall 24. These walls 20 and 24 are secured to the outer shell 12 by adhesive bonding and can engage with support brackets 25 adhesively secured to (or integrally formed with) the shell 12 for additional strength (other means of bonding these walls to the shell are possible). These walls 20 and 24 are compressed between the upper 14 and lower 16 portions of the shell 12 to form watertight seals, and may be likened to bulkheads which divide the interior of the shell 12 into three separate watertight compartments 30, 32 and 34, so that if the board is holed in use only one compartment becomes waterlogged whilst sufficient buoyancy may be provided by the remaining compartments to keep the board afloat.

The shell 12 and walls 20, 24 preferably comprise a carbon fibre-epoxy/honeycomb sandwich structure, best seen in Figures 3 & 4, which is advantageous for the board structure as providing a high strength to weight ratio. This sandwich structure has an outer skin 40 of layers of composite materials, usually carbon fibre reinforced plastics, and an inner skin 42 of similar composite materials which encloses a lightweight core material 44 such as a honeycomb material sold under the Trade Mark NOMEX. The outer skin 40 may be thicker than the inner skin 42 to resist impact loads normally encountered when in use.

In order to obtain a monocoque design of the board 10 as above described - that is where the shell 12 may act as a framework - the choice of material requires high strength to weight ratio. This is typically achieved by using carbon fibre reinforced plastics which may also include additional fibres of glass, the material as sold under the Trade Mark KEVLAR (aramid), ceramic, polyethylene and other thermoplastics fibres (although, preferably, carbon fibres predominates). The plastics materials for the skin of the board are usually resin pre-impregnated (prepregs) . The resin systems used in these "prepregs" are typically thermoset epoxy or thermoplastics (typically polyetherimide or poly ether sulphone). These composite prepreg materials when cured can provide high strength to weight ratios and are widely used in aircraft design where these properties have been successfully exploited. The core material will usually be of a honeycomb structure such as that sold under the Trade Mark NOMEX, although other lightweight materials such as carbon or glass fibre may be used. Alternatively, a structural rigid foam may be used for the core-material or even a mixture of cork and resin (typically epoxy resin). The honeycomb structure will usually comprise an array of hexagonal tubes exhibiting high compression resistance lengthwise of the tubes and in the direction through the thickness of the shell, due in part to the material of the structure but mainly due to the rigidity of the structure itself. However, the honeycomb structure 44 has limited compression resistance in a direction normal to the extent of its hexagonal tubes and is therefore stabilised by incorporating it in the composite material sandwich between the tough inner and outer skins 40 and 42 respectively. The resulting sandwich structure has a very high strength to weight ration, a hollow board constructed by this material achieves a weight saving of 25-30% in comparison with similarly sized conventional boards with an approximate three fold increase in stiffness and strength.

In a preferred structure of the composite material sandwich, as seen in Figures 5 and 6, the outer skin 40 is formed by three layers of different materials, an outer layer (0.5mm) of glass-Dyneema woven/epoxy prepreg (160g/m² at 50% by weight resin), a second layer (0.17mm) of carbon unidirectional/epoxy prepreg (160g/m² at 45% by weight resin) and a third layer (0.25mm) of aramid woven/epoxy prepreg (165g/m² at 50% by weight resin). The core of the composite material sandwich is NOMEX (Trade Mark) honeycomb (6mm thick) typically 48Kg/m³ density having a hexagonal tubular cell size of 3mm and this is layed on the third layer of the outer skin. The inner skin 42 comprises a single composite layer (0.25mm) of aramid woven/epoxy prepreg (165g/m² at 50% by weight resin) which sandwiches the honeycomb material with the third layer of the outer skin 40 towards the laterally opposed edges of the board, this inner skin 40 layer being bonded to the above mentioned third layer of the outer skin 40 to completely enclose the core material.

A benefit which has been found by use of the aforementioned composite materials is the increased temperature resistance and thermal stability which they afford to the board in comparison with conventional material for such boards. The composite materials may give the board a continuous operating temperature of about 120°C, much higher than the temperatures at which conventional boards maintain structural stability. Boards can reach temperatures of up to 70°C in some parts of the world and at this temperature blowing agents (which are residual in polystyrene cores of conventional boards) begin to expand and distort the board. For this reason conventional boards are not usually provided with a dark colour surface finish to alleviate residual heat absorbtion. The board 10 of the present invention alleviates the aforementioned problem of thermal distortion and may therefor be provided with any surface finish, including black, as required.

In order to further enhance the stiffness of the board 10 each compartment 30, 32 and 34 may contain an inflatable envelope 50, 52 (shown in Figure 2 in compartments 32 and 34 respectively) in the form of a bladder. Each envelope has a valve 55 communicating with the exterior of the shell 12 through which the envelopes 50, 52 can be pressurised by a pneumatic pump. The resulting force exerted on the

shell 12 by the pressurised envelopes can serve to increase the rigidity and strength of the board 10 and provide increased resistance to denting of the outer skin 40 without significantly increasing the weight of the board 10.

Alternatively, the envelopes 50 and 52 may be inflated with a gas which is lighter than air, such as helium, which would serve to increase the buoyancy of the board (by making it lighter) while increasing its rigidity.

Furthermore, by varying or adjusting the gases used and/or the pressure applied to the different envelopes, the trim of the board may be adjusted to suit individual requirements of the user or, as appropriate, the weather conditions (it is the practice among windsurfers to use heavy boards during rough weather and lighter weight boards during calmer weather). Thus, the ability to vary the buoyancy (or weight) of the board, by pressurisation of the envelopes and/or the use of different density gasses for the pressurisation, alleviates, to a large extent, the need for several boards of different weights. Also, the buoyancy of the board may be adjusted to suit a users requirements, especially in the region in which the user may take his stance on the board.

The shell 12 of the board 10 has integrally formed therein a mast box 60 and a power box 70 (Figures 3 & 4 respectively) for respectively accommodating a mast and control fin (not shown). Both upper and lower portions, 14 and 16, of the board 10 are simply moulded for convenience of mass production, and furthermore can be shaped to any required design so as to integrally comprise the mast box and control box respectively.

Figure 3 illustrates the mast box 60 (with a socket for receiving a mast) integrally moulded with the upper portion 14 of the board 10 and comprising a similar array of several layers of composite materials used for the skin, although the honeycomb core 44 is not incorporated in the mast box 60 make up. Alternatively, the mast box 60 may comprise a one piece plastics moulding which is adhesively bonded into the cured board. The longitudinally extending wall 20 has a section removed to accommodate the mast box 60 when the upper 14 and lower 16 portions of the board are bonded together. A watertight seal between the chambers 32 and 34 is maintained by surface 61 of the mast box 60 being adhesively bonded to, and forming a watertight seal with, the wall 20.

The power box 70 (Figure 4) may also be formed integrally with the board 10, towards the rear apex 22, to accommodate the control fin (not shown). The lower portion 16 of the shell is moulded to have a narrow, longitudinally extending, recess 72 which is to receive the fin. The walls of this recess 72 are formed of several layers of the composite material which is used in the formation of the skin (with the exception that the core material 44 is omitted). However, to strengthen this region of the board in which the power box 70 is located, the surrounding structure of the shell has an increased core thickness 75. Similarly, the upper portion 14 of the shell 12 in the region of the power box 70 is also strengthened by increasing the thickness of the core material 44 (as shown at 75a). Furthermore, the walls forming the recess 72 abut and are bonded to the inner surface of the thickened upper portion 14 to provide a strong, firm structure whilst alleviating the difficulty of forming the recess 72 around the core material 44. If required, the walls of the power box recess 72 may be formed as a one piece plastics moulding which is built into the shell similarly to that previous described.

In order to secure the control fin to the board 10 a securing bolt (not shown) extends through the upper portion 14 of the shell 12 and into the recess 72 to engage the fin and maintain it within the recess 72. To accommodate this bolt, a bolt hole 86 is provided in the upper portion 14. A location 80 for the bolt hole 86 may be moulded integral with the shell and comprise layers of composite materials similar to those used in the skin of the shell. Additional layers of composite material may be used to form the location 80 for the hole 86 to provide an increased strength in this region. The bolt hole location 80 presents an external recess in the board within which a head of a bolt in the hole 86 may be accommodated. If required the bolt hole location 80 can be formed as a one piece plastics moulding which is built into the shell similarly to that previous described. When the upper and lower portions of the board 10 have been connected together the bolt hole 86 is extended to provide a bore 84 which communicates with the recess 72. Since the walls of the recess 72 are bonded to the upper portion 14, the bore 84 is sealed from communication with the interior of the shell 12.

Boards constructed in accordance with the present invention will usually require a process of manufacture involving curing prearranged layers of composite materials under pressure. The boards can either be made by the laying-up and curing of each of the upper and lower portions separately and then combining them together or by laying-up the two portions separately and curing them together as a complete board.

Figures 5, 6 and 7 are referred to for illustrating the preferred techniques for manufacture of the board 10. One manufacturing process involves laying-up the materials in separate moulding tools for each of the upper and lower portions 14, 16, manufacturing (including curing) walls 20, 24, moving the moulding tools into overlying and abutting relationship to form the uncured shell with the walls 20, 24 correctly positioned between the uncured upper and lower portions of the shell, and curing the material of the shell under pressure.

The upper portion 14 is formed using a moulding

tool 90 (Figure 5) which is shaped to the required part surface profile of the board 10. Carbon fibre/epoxy prepreg materials used for the skin of the board are usually retained in cold storage and should be allowed to reach room temperature before use, these materials are then cut into appropriate ply shapes using automated cutting apparatus. The honeycomb core material 44 is taken from a standard sheet and also cut to prerequisite shape using automated cutting apparatus. The composite layers are then layed-up in the correct order, as previously discussed, in the moulding tool 90. As can be seen from Figure 5, the core material tapers in thickness towards each of the opposed longitudinally extending, peripheral edges 101 and 102 of the upper portion 14. At the actual edges 101, 102 there is no core material and these edges are formed by layers of composite materials. The edges 101 and 102 of the upper portion 14 are then folded inwardly, while in a flexible state, to form the inwardly projecting flange 14a of the upper portion 14. The materials for the flange 14a are held in their folded state by flange plates 104 and 106 which are bolted onto a top surface 91 of the moulding tool 90 by bolts 105 and 107 respectively. Situated along the flange plates are air tight seals 110 connected to which is a flexible diaphragm or vacuum sheet 112. This sheet 112 extends across the moulding tool 90 to completely enclose the materials in the cavity of that tool. A centre region of the sheet 112 has connected to it a vacuum breach unit 120 connected by a vacuum hose 122 to a vacuum pump (not shown).

Tubular spigots 128 extending from the moulding tool 90 project through the thickness of the composite layers for the upper portion 14 as layed up to provide bores which open to the exterior of the moulding tool 90. The spigots 128 are connected to tubes 130 which may be closed or opened as required for the admission of gas under pressure into the cavity of the moulding tool 90 or the withdrawal of gas from such cavity.

With the board composites layed up within the moulding tool 90, as in Figure 5, the vacuum pump is activated to remove (by way of hose 122 and possibly tubes 130) the air enclosed within the cavity of the moulding tool 90 by vacuum sheet 122. This vacuum serves to create a pressure differential which causes the sheet 122 to be forced against the layed-up materials to consolidate those materials to the required profile in the moulding tool. This applied compressive force also tends to compact the material layers together. The vacuum is then removed from the vacuum sheet 112 and this sheet is then removed from the moulding tool 90. The flange plates 104 and 106 are also removed from the moulding tool.

The lower portion 16 of the board 10 is formed in moulding tool 130 (Figure 6) which has a moulding cavity profiled to the required shape of this portion of the board. Similarly to the upper portion 14, the layers of composite material are cut and layed-up within the moulding tool 131 in the order previously discussed. As with the upper portion, the core material 44 tapers towards opposed longitudinally extending edges 140 and 141 of the lower portion 16, so that at these peripheral edges 140 and 141 there is no core material 44 and the edges are formed by layers of the composite materials used for the skins. The edges 140 and 141 are clamped by flange plates 142 and 144 respectively which are bolted onto the moulding tool 131 by bolts 145 and 146. Although not shown in Figure 6, a vacuum sheet, similar to that at 112 in Figure 5, is then connected to the mould in the manner described for the upper portion 14 and similarly a vacuum is applied beneath the sheet in the cavity of the moulding tool to compress the composite layers against the mould profile. Once this has been completed the vacuum sheet is removed along with the flange plates 142 and 144.

During these laying-up procedures, provision is made in the cavity profiles of the moulding tools for the mast box 60 and the power box 70 which are formed integral with the appropriate board portions. For the mast box 60, Figure 3, a set of three male mould inserts (not shown) are located in the upper portion moulding tool 90 and the composite layers are formed around these inserts. In this region the core layer 44 has a hole cut to accommodate the mast box and is arranged so that the mast box passes through this hole. Additional layers of the composite materials are formed about the mould inserts to give additional thickness and strength to the mast box 60. A similar technique is used to form the power box 70, using male mould inserts about which the composite layers are formed and the core material 44 is cut to accommodate the adjusted shapes caused by the mould inserts. The corresponding bolt hole 80 is also formed in this manner and, like the mast box, additional layers of composite materials are used to strengthen this region in the absence of the core material 44. Although if the mast box 60 and/or the power box 70 are provided by preformed plastics mouldings such mouldings are appropriately positioned in the respective cavities of the moulding tools prior to laying up the composite layers about the mouldings.

The walls 20 and 24 may also be moulded as individual body parts and will usually be in the form of flat panels. These walls 20 and 24 may be made by laying up the materials in an appropriately designed mould tool (not shown) with a layer of honeycomb core material (typically 8mm thick, 48kg/m^3 density, 3mm cell size) sandwiched between two layers of ply woven carbon/epoxy prepreg (190g/m^2 at 50% by weight resin) which is cut from sheets to the appropriate size. These layers for the walls 20, 24 are then moulded together by exerting a pressure of 3 bar while heating the mould to 125°C and curing for 45 minutes.

The next stage in the first manufacturing process is to combine the uncured upper and lower portions 14, 16 together, whilst still in their respective moulding tools, to, in substance, define the shape of the board 12 with the walls 20 and 24 disposed between the two body portions 14, 16. To achieve this, the walls 20 and 24 may be adhesively tacked in their required positions within the uncured upper portion 14 of the board (with that upper portion 14 still in its moulding tool 90) by use of a heat gun to melt the tacking adhesive. Adhesively secured support brackets 25 can also be used to hold the walls in the required position on the board, which brackets are themselves adhesively secured to the board.

Next, bladders 50, 52 are inserted in the upper portion 14, within the moulding tool 90, one in each of the chambers which is to be created by the walls 20, 24. These bladders 50, 52 are each connected to the individual air inlet tubes 130 (Figure 5) by way of the tubular spigots 128. The bladders 50, 52 are preferably made and arranged so that their external surfaces bond to the prepreg materials of the internal skin of the shell 12 as it is cured (thereby forming a permanent liner to the board 10). Preferably, the material used for the bladders 50, 52 is a fluoropolymer plastics film as this material tends to reduce the formation of condensation as the temperature of the board fluctuates during use.

The lower portion moulding tool 131, with the uncured lower portion 16 therein, is placed on top of the upper portion moulding tool 90, as shown in Figure 7, so that the flanges 14a and 16a are overlying and abutting. When the moulding tools 90, 130 are in this position the walls 20, 24 will be compressed tightly between the uncured upper and lower portions 14 and 16 of the board 10 and the bladders 50, 52 enclosed in the chambers created by the walls. The completed assembly of the moulding tools 90 and 131 is then transferred to a press 160 which applies a clamping pressure of 20 bar on the moulding tools (Figure 7).The mould assembly is then heated to a temperature of 80°C by circulating pre-heated oil through heating tubes 164 integrally incorporated in the moulding tools. Heating the mould assembly in this manner allows a controlled even temperature to be applied. Simultaneously, compressed air is applied to each of the bladders 50, 52 through the respective tubes 130 and spigots 128 to a pressure of 3 bar. This internal pressure forces the bladders 50, 52 against the internal surface of the inner skin of the board shell to compress the layers of composite materials between the bladders and the moulding tools. The mould temperature is then further increased to 130°C for one hour to cure the prepreg materials. During this curing stage, the flanges, 14a and 16a of the upper 14 and lower 16 portions of the board 10 are adhesively secured/bonded together under pressure, the adhesive being cured by the temperature applied to the mould. Similarly, the walls 20 and 24 are adhesively secured/bonded to the inner surface of the upper and lower portion 14, 16 forming watertight seals and a rigid structure for the moulded board.

The mould is then cooled to a temperature of about 30°C by passing chilled water through the tubes 164, the inner pressure of 3 bar is released from the bladders 50, 52 and finally the external clamping pressure is removed. The mould assembly can then be opened and the completed board extracted. The mould inserts can now be removed from the power box 70 and mast box 60 and valves 55 fitted to the bladders 50, 52 in the ports formed by the removal of the spigots 128 from the moulded upper portion 14.

It can be seen here that the bladders 50, 52 serve several purposes, they can used to apply an internal pressure to the shell 12 of the board during the curing process, they may be used to adjust the buoyancy of the board when it is in use, they may be used to adjust the rigidity of the board in use, and they can also provide a waterproof lining within the hollow board. It is to be appreciated however, that although the bladders 50, 52 are preferred, their presence in the structure of the board is not essential to the present invention.

The board may be finished in a conventional manner by removing flashes to provide an acceptable surface finish, painting, decorating and adding fasteners to the board as appropriate, for example to allow foot grips/handles 170 (Figure 1) to be connected to windsurfing boards.

In an alternative method of manufacturing the boards as herein described, the two separate upper and lower portions of the board are layed-up in respective moulding tools 90, 131 in a similar manner to that previously described and each such portion is cured separately. By this method, when the materials have been layed-up in their respective moulding tools the vacuum sheet 112 is used to apply a pressure of 3 bar to the materials layed-up in the mould cavities while the moulding tools are heated to about 130°C to cure the composite materials. The walls 20, 24 and bladders may then be positioned and secured between the cured upper and lower portions and these portions adhesively connected or bonded together.

It will be appreciated that there are numerous practical uses of the board of the present invention, such as a surfboard incorporating an integral fin, or a float as used on a catamaran or raft. It will also be appreciated that more than two walls may be used to create more watertight compartments (which may or may not contain an inflatable bladder/envelope). Also, the compartments may be of an airtight construction (without bladders) so that they can be pressurised directly. It is also possible to remove all the internal walls so that the hollow board has a single large compartment that may, or may not, be pressurisable.

The shape of the board may be easily changed as determined by the moulding tools, and perhaps incorporating more than two portions to be bonded together. The board may be constructed using more than two layed up portions (rather than merely upper and lower portions as described for the preferred embodiment).

Claims

1. A float board comprising a watertight shell, said shell being hollow and having a wall structure with an outer surface presented by a cured resin composite material.

2. A board as claimed in claim 1 in which the wall structure comprises a double skin of moulded composite material having a core material disposed therebetween.

3. A board as claimed in claim 2 in which the core material comprises a honeycomb layer.

4. A board as claimed in any one of the previous claims in which the composite material comprises carbon fibre reinforced plastics material.

5. A board as claimed in any one of the preceding claims in which the hollow shell has at least one internal support part comprising at least one layer of cured resin composite material.

6. A board as claimed in claim 5 in which the support part comprises a double skin of said composite material sandwiching a core material.

7. A board as claimed in either claim 5 or claim 6 in which the support part divides the interior of the shell into at least two chambers.

8. A board as claimed in any one of the preceding claims in which pressurisation means is provided for adjusting the internal pressure of the shell and thereby the stiffness of the board.

9. A board as claimed in claim 8 in which the pressurisation means comprises at least one envelope within the shell and valve means communicating with the exterior of the shell through which pressure within the envelope is adjustable.

10. A board as claimed in claim 9 when appendant to claim 7 in which the or at least two said chambers each have a separate said envelope with associated valve means by which each said envelope may have the pressure therein individually adjustable.

11. A board as claimed in any one of claims 8 to 10 in which the pressurisation means comprises gas under pressure retained in the shell.

12. A board as claimed in any one of the preceding claims and comprising a mast box and a power box may be formed integral with the moulded shell.

13. A board as claimed in any one of the preceding claims in which at least one stabilizing fin is formed integral with the moulded shell.

14. A board as claimed in any one of the preceding claims in which the shell comprises at least two separate moulded portions adhesively secured or bonded together.

15. The combination of a float board as claimed in any one of the preceding claims and a mast and sail attached to said board.

16. A method of making a float board, having a hollow shell, which comprises laying in each of at least two mould cavities of respective moulding tools a layer of composite material having resin impregnation, curing said resin impregnated materials to form shell parts and securing the shell parts together by at least one of bonding or adhesion to provide the hollow shell with a watertight external surface presented by the cured resin composite material.

17. A method of making a float board, having a hollow shell, which comprises laying in each of at least two mould cavities of respective moulding tools a layer of composite material having resin impregnation, consolidating said resin impregnated layers in their respective mould cavities by the application of pressure to form un-cured shell parts, uniting the moulding tools such that the un-cured shell parts are assembled to form a hollow un-cured shell, applying an internal pressure to the hollow un-cured shell while curing the resin impregnated material to secure the shell parts together by at least one of bonding or adhesion.

18. A method as claimed in either of claims 16 or 17 which comprises laying a core layer of honeycomb material between successive layers of the resin impregnated composite material.

19. A method as claimed in claim 17 or in claim 18 when appendant to claim 17 in which said consolidation of the layers comprises placing an airtight lining across each moulding tool to overlie the layers in the tools and applying a vacuum between the lining and the tool to cause a pressure

differential by which the resin impregnated material is compressed against the moulding tool.

20. A method as claimed in any one of claims 16 to 19 which comprises inserting at least one inflatable envelope between the shell parts.

21. A method as claimed in claim 20 when appendant to claim 17 which comprises inflating the envelope or envelopes during the curing of the resin impregnated material to compress the un-cured shell parts against their respective moulding tools.

22. A method as claimed in any one of claims 16 to 21 which comprises locating at least one support part between the shell parts to divide the hollow shell into at least two chambers.

23. A method as claimed in claim 22 when appendant to claim 20 which comprises locating a said envelope within each of at least two said chambers.

24. A method according to any one of claims 16 to 23 which comprises incorporating at least one of a power box and a mast box with the resin impregnated composite layer during the laying up of said layer.

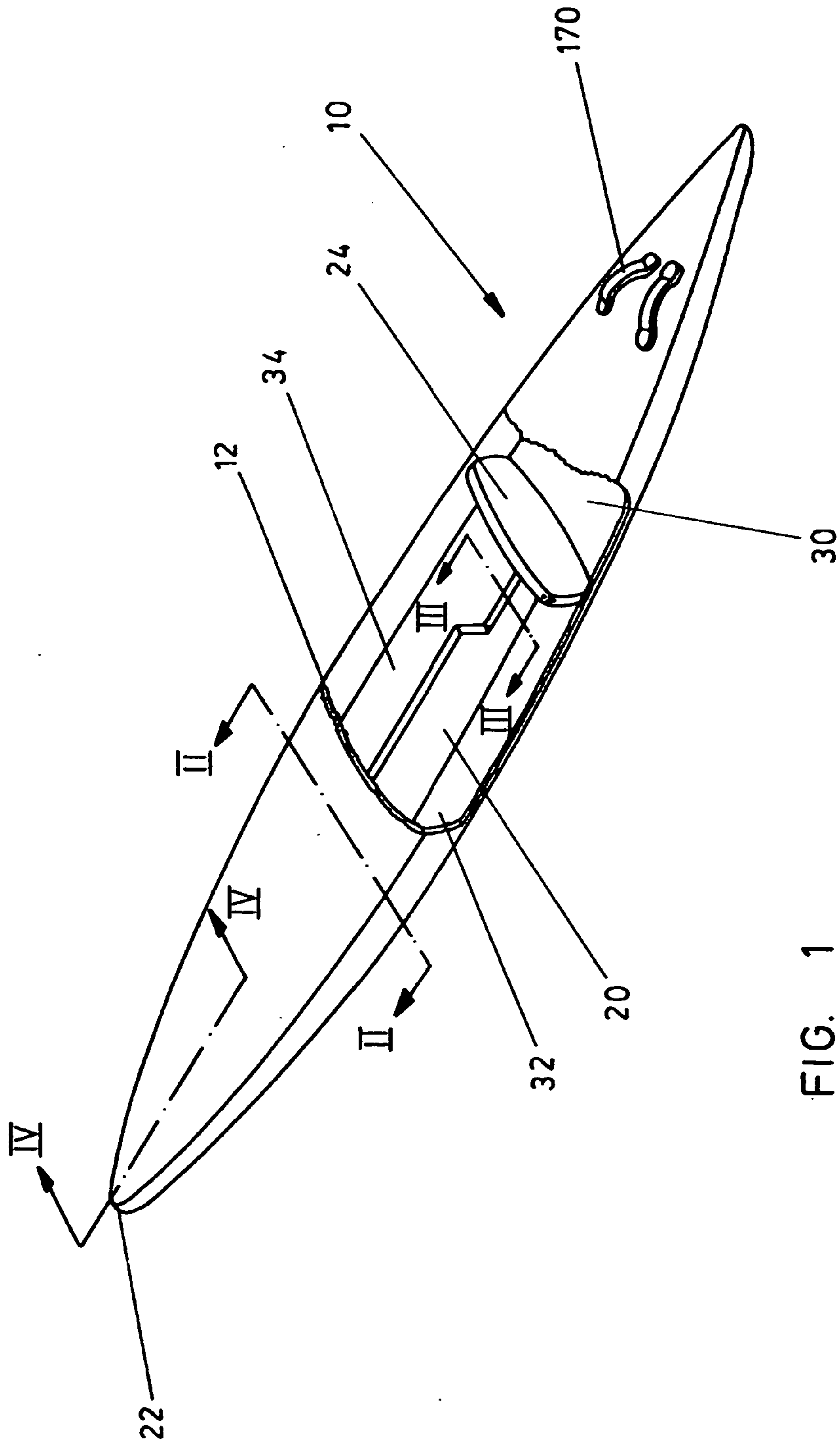

FIG. 1

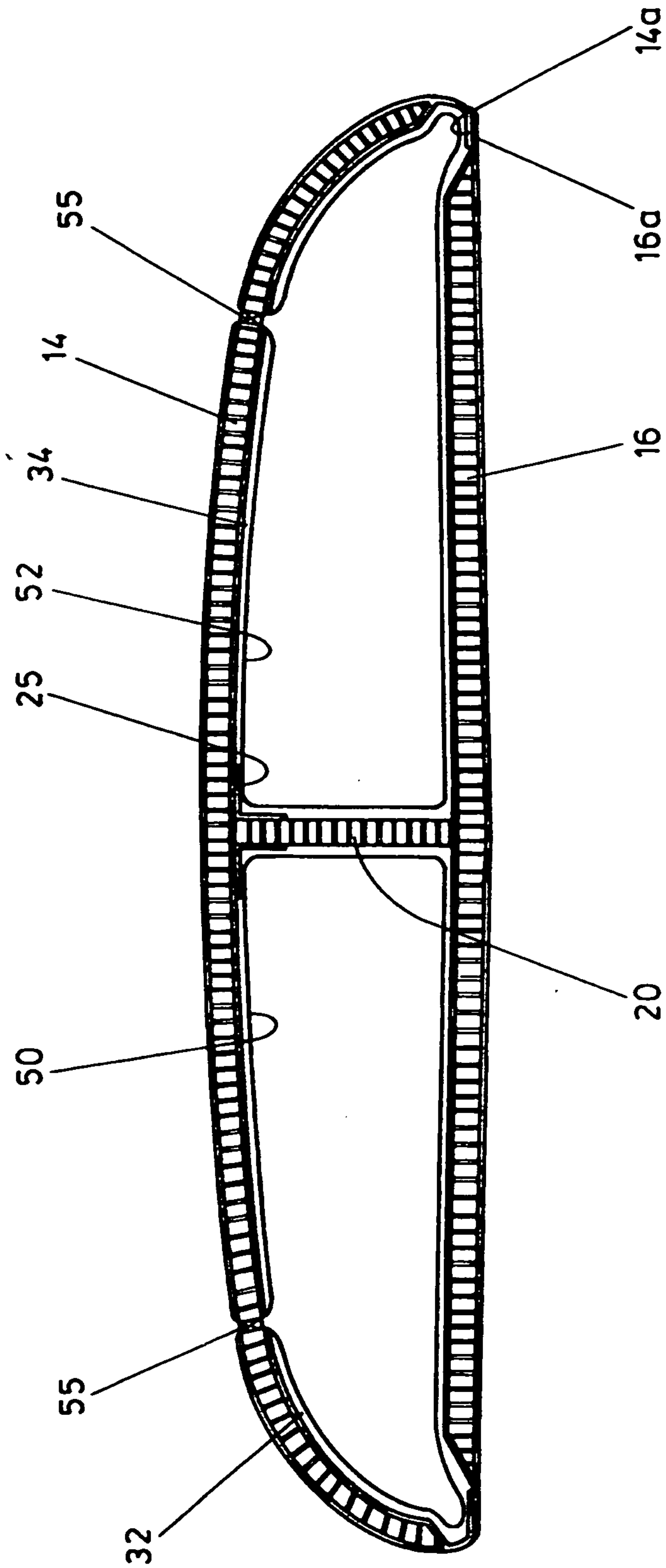

FIG. 2

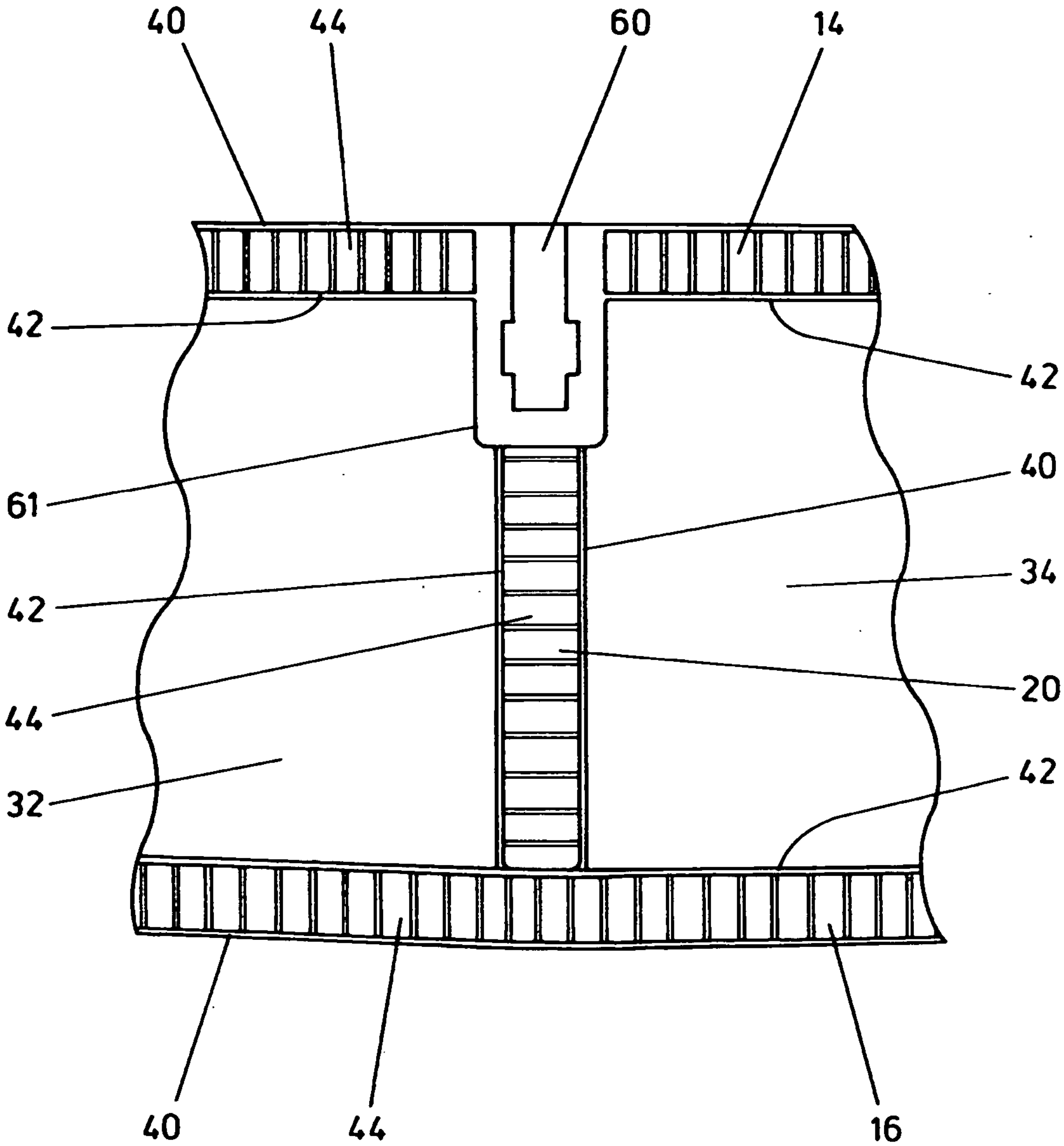

FIG. 3

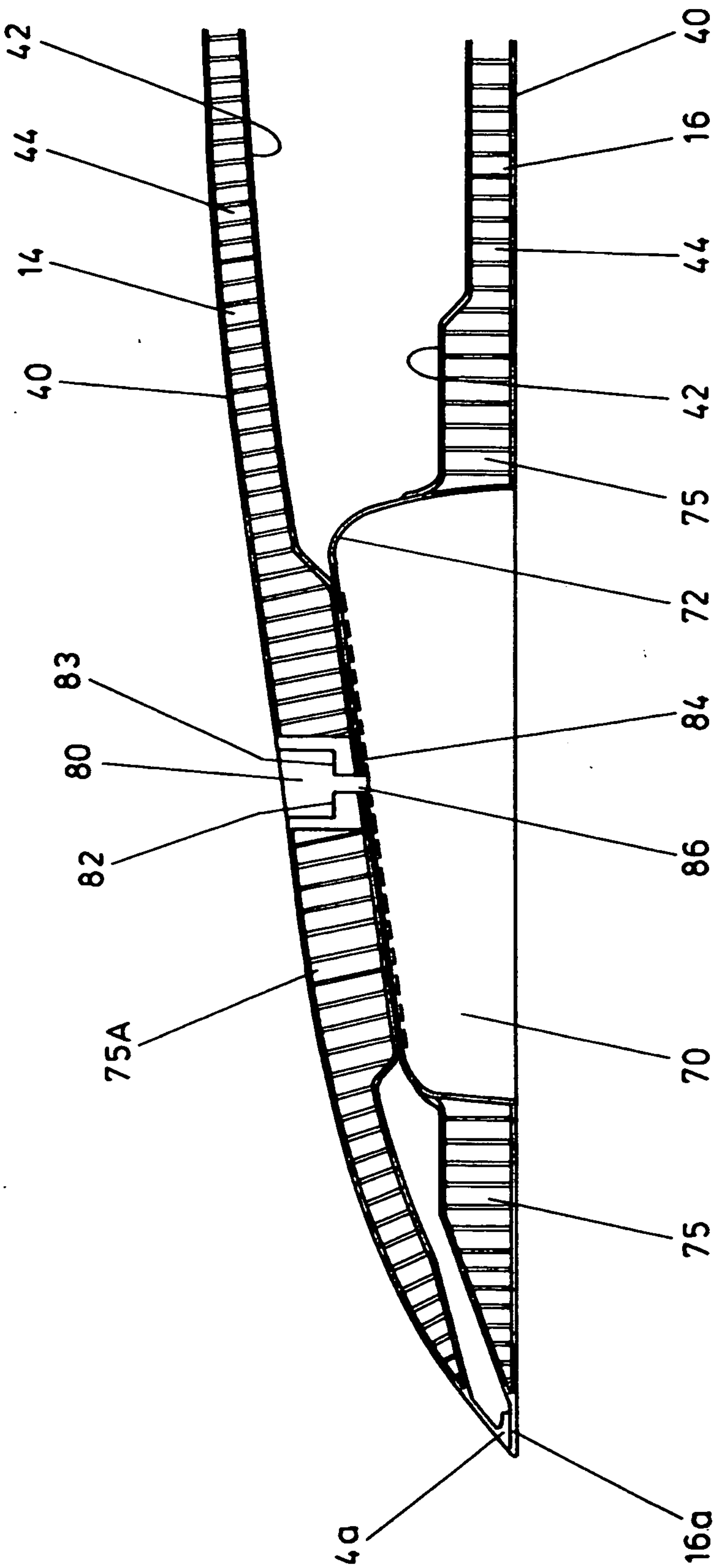

FIG. 4

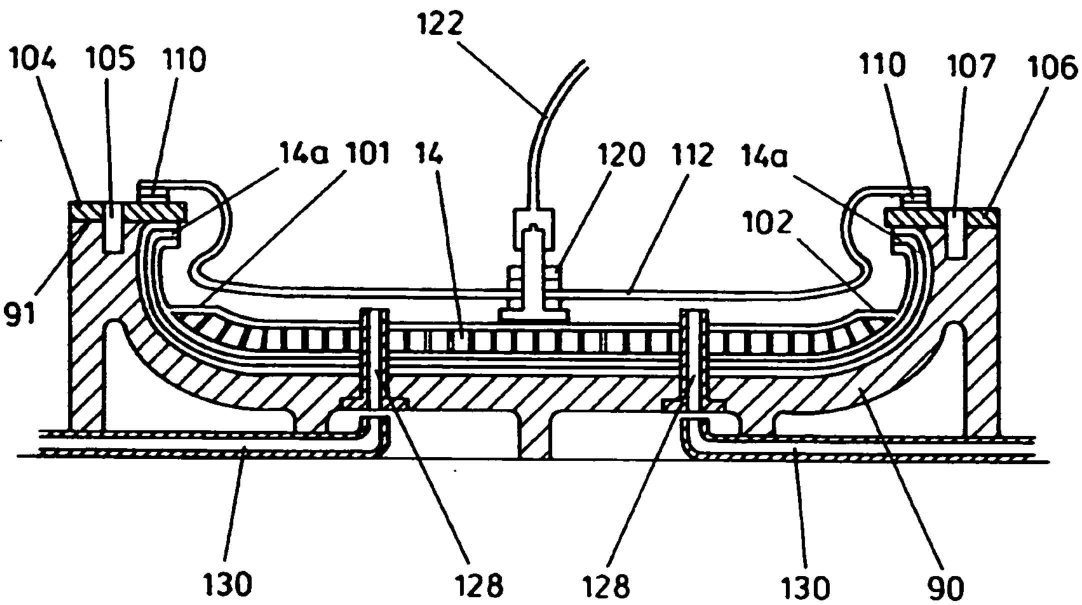
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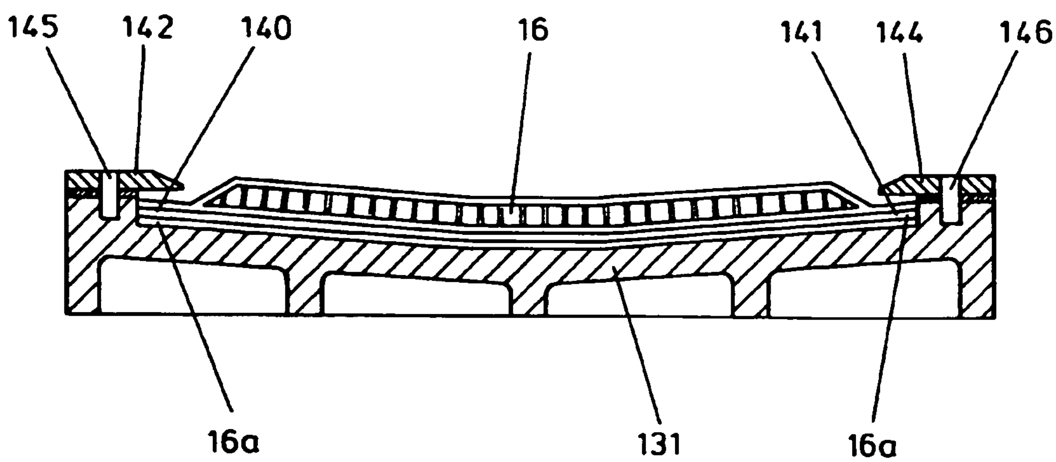
FIG. 5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146
16a
131
16a

FIG. 6

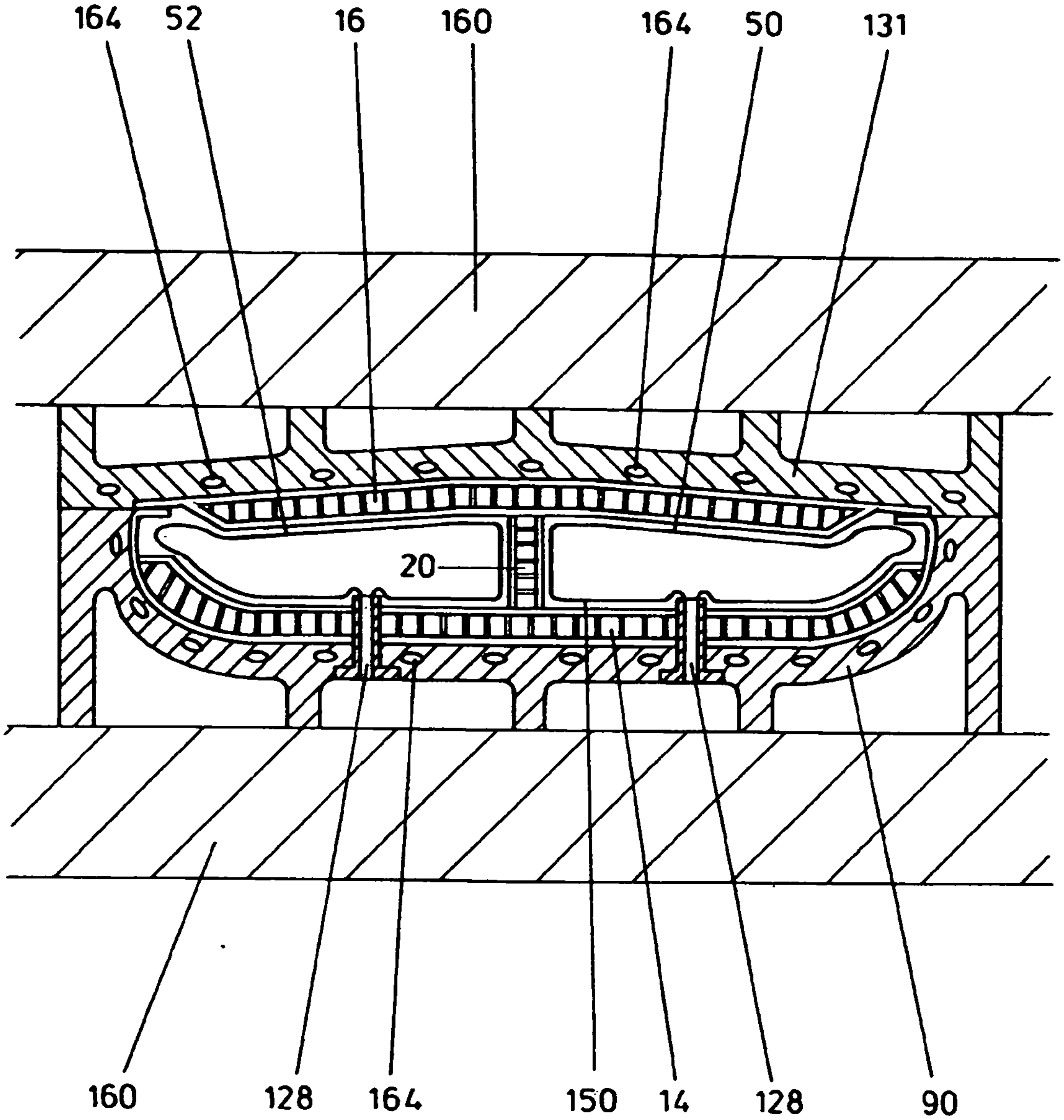

FIG. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 30 4600

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-4 964 825 (PACCORET ET AL)	1-7, 12-16	B63B35/79
Y	* the whole document *	8-11, 17-24	
Y	DE-A-2 829 380 (MARKER)	8-11	
A	* page 6, line 15 - line 21; figures 1-3 *	1-5	
Y	FR-A-2 336 954 (LABAT)	17-24	
A	* page 3, line 10 - line 20; figures 1-7 *	1-7	
Y	WO-A-9 001 410 (GRAF)	19-24	
A	* the whole document *	1-7	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B63B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 SEPTEMBER 1993	DE SENA A.

CATEGORY OF CITED DOCUMENTS

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